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Teamwork Assessment Scales for C2 Functions of Battalions and Brigades

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This report offers an extensive review of various team literatures, including research from the areas of command and control and industrial/organizational psychology. A complete set of references is included. Leading models of team performance are identified, and, along with their assessment tools, they are analyzed for similarities in concepts, dimensions, behaviors, and behavioral anchors. Based on this analysis, a comprehensive model of advanced team performance (ATP) has been generated and an assessment tool is being developed. Plans for field testing are outlined.

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Teamwork Assessment Scales for C^2 Functions of Battalions and Brigades

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Contents

Contents

List of Figures and Tables

Teamwork Assessment Scales for C^2 Functions
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Goals of the Effort

The primary goal of this effort is to develop a method for distinguishing effective from ineffective teams, so as to identify appropriate training interventions. At completion, the Army will be able to train observer-controllers to observe teamwork processes during field exercises, whether at a training center such as National Training Center (NTC) or at a home station, and to identify effective and ineffective teamwork processes. The value of these field exercises will also be increased, because participants will be learning how to work together effectively as teams at the same time they are practicing the skills needed to accomplish their tasks. In other words, the same exercise that was used to train specific job skills will also be used to improve teamwork skills.

In order to achieve this goal, we have identified a number of specific objectives:

- Deriving a model to guide the evaluation of team performance.
- Formalizing the methods, developed in Phase I of this study, for measuring the effectiveness of team assessment techniques.
- Increasing the efficiency of using the assessment techniques.
- Demonstrating the reliability of the methods.
- Demonstrating the versatility of the assessment technique for field observations in different command-and-control units.
- Developing training for observer-controllers, to assess teamwork processes under field conditions.
- Ensuring that the teamwork assessment scales and observation techniques can be directly applied for improved training, via direct feedback, improved planning, and supplementary instruction.

The most important of these enabling objectives is to derive a model to guide the evaluation of team performance. This model must be dynamic enough to capture the behaviors observed and identified during the Phase I study. We also believe that, in order for it to be effective, the model must have a cognitive perspective and view the team as a single entity rather than concentrate on individual team members.

Thordsen, Klein, Wolf, and Banks (1993), in the Phase I effort, took the first step in developing such a model by portraying a team as a unitary cognitive entity. They suggested

that teams have minds functionally analogous to those of individuals. In contrast to looking at the team by studying the individual team members, they chose to treat the team mind as an emergent entity and focused attention on the team itself and the way it thinks.

This approach led them to develop the Cognitive Model of Teamwork which articulated ways to gain access to the cognitive processes of teams, the cognitive processes themselves, and the ways that teams mature. They identified a number of cognitive processes which are applicable both to individuals and to teams. These included selective attention, metacognition, memory, and intential behavior (Thordsen et al., 1993).

They considered two dimensions along which teams mature. The first of these, Team Identity, refers to the ability of individual members of a team to see problems and tasks from a "team-centered" perspective rather than an individual one. To illustrate: as a child develops, its view of the world "decenters" from a self-oriented perspective, and the child becomes capable of seeing things from another person's point of view. At the team level, Thordsen et al. (1993) suggested that the maturation of identity also involves a decentering—team members need to give up their individual perspective and learn how to regard themselves as part of the larger team.

The second dimension, Perceptual Focus, refers to the ability of the individuals and the team as a whole to look further than the "here and now" and to examine future consequences, trends, and tradeoffs. Returning to the metaphor of the child, an infant trying to reach for a ball that is rolling along the ground is comical to watch since it reaches for where the ball is at the moment, and by the time the hand gets to that point, the ball has moved. Analogous to the infant's inability to anticipate where the ball is going to be, new teams made up of relatively inexperienced people often do not appreciate the lags in the team's reaction times. They may respond to events which they have no ability to affect.

The results of the Phase I study thus serve as a guide in this Phase II effort. We intend to expand and refine the concepts identified during Phase I in order to develop a method for evaluating command-and-control teams.

The current effort is a SBIR Phase II contract with the U.S. Army Research Institute. The Phase I was carried out from August 1990 to June 1991. During the feasibility study the cognitive model of teamwork was successfully used to generate observable behaviors; the behaviors were demonstrated during a field exercise; a set of specific scales were generated for use by observer-controllers (OCs) during field exercises; and several data analysis strategies were derived for assessing team development. This study was considered a success in that it demonstrated the viability of our methodology and began the development of a technique for assessing team performance and improving team training.

The Phase II contract began on August 31, 1992. We are presently 10 months into the 24-month project.

Approach

Our approach began with a comprehensive literature review and the development of an expanded model of team performance. A number of models of team development/ performance have been considered and analyzed. This effort will be described below. Finally, we will field test and evaluate the model to ensure that it is applicable to the needs of the Army.

The Phase II effort was initially planned as eight tasks: 1) conduct literature review, 2) revise models and measures, 3) prepare interim report, 4) conduct domain testing and modification, 5) develop instructional package, 6) conduct field testing and modification, 7) prepare training modules, and 8) develop database. Early discussions with the contract monitor resulted in a reassessment of priorities. The last two tasks are now considered low priority and efforts will be concentrated on accomplishing the first six.

The first task, the literature review, has been completed. An extensive review of the command-and-control team literature, the industrial/organizational psychology literature, and other aspects of team literature was conducted in order to further our understanding of the relationship between the ATDM model and other accounts of team performance.

We are in the process of completing the second task, developing the model of team performance called Advanced Team Performance (ATP) and the assessment tool. Below we will discuss the most recent form of the model which has evolved as a result of the information gained during the literature review and our progress with the assessment tool.

The third task is the preparation of this interim report, describing our methods and documenting our progress thus far.

The fourth task will involve domain testing and modification of both the model and the assessment tool. This will include domain testing possibly using SIMNET for two separate exercises. The information gained in each exercise will be used to test, evaluate, and improve the assessment tool, and improve the model.

The fifth task will consist of the development of an instructional package, aimed at observer-controllers, that will describe both the logic underlying the model and assessment tool, and the use of both. Input from experienced military personnel will be solicited throughout the development of the instructional package, to ensure that appropriate Army field personnel will be able to use it.

The sixth task will be an actual field test and evaluation of the assessment tool. It is planned that this will be carried out over time with two battalion-level command-and-control teams. The assessment/intervention will be done first at each team's home station, and then again at their respective combat training centers (CTCs). The field test will aid us in

determining whether the final version of the methodology can be applied in the real-world, tactical military environments of operations and planning.

ATDM Model

The cognitive model of teamwork presented after the Phase I effort has been further developed into the Advanced Team Decision Making (ADTM) model (Zsambok, Klein, Kyne, & Klinger, 1992), in a recently completed Phase II project funded by the Army Research Institute. This ATDM model has served as a starting point for this Phase II effort, rather than the earlier Phase I version.

The ATDM model consists of three primary components: Team Identity, Team Conceptual Level, and Team Self Monitoring.

Team Identity describes the extent to which team members conceive of the team as an interdependent unit, and then operate from that perspective while engaged in their tasks. In other words, are the team members able to decenter from their individual roles to consider the team as a whole? Team Conceptual Level captures the notion of a team as an intelligent entity, a "team mind" that thinks, solves problems, makes decisions, and takes actions collectively on a level of complexity and sophistication that matches the demands of the task. Team Self Monitoring is a regulatory process for all other processes described in the model. Self monitoring is a master tool which helps teams promote advanced team decision making, moving from weak to strong identity and from a low to high conceptual level by determining how successfully the team is using key behaviors. Team Self Monitoring by definition is the ability of a team to observe itself while acting to accomplish its tasks.

These components are further delineated by behavioral markers (see Figure 1). Through observation of many teams, Zsambok et al. (1992) have identified concrete and directly observable behavioral markers, which are intended to help team members see what their team is doing so as to improve along the dimensions described above. These behaviors were selected to be easily learned, observed, and used.

For the component of Team Identity there are four markers. The first of these, defining roles and functions, concerns the extent to which teams take care to ensure that all their members know what they are expected to do to attain the team goals. The behavioral marker of engaging concerns the extent to which team members are involved in the team task and their own functions. The third marker, compensating, is the ability of team members to step outside their assigned roles or functions and perform different ones in order to help the team reach its goals. It is not enough for team members to compensate when problems arise. Advanced teams also try to learn what caused the problem. The fourth behavioral marker, avoiding micromanagement, is key to advanced team performance. Team members must avoid the temptation to manage information, tasks, or people at an inappropriate level of detail.

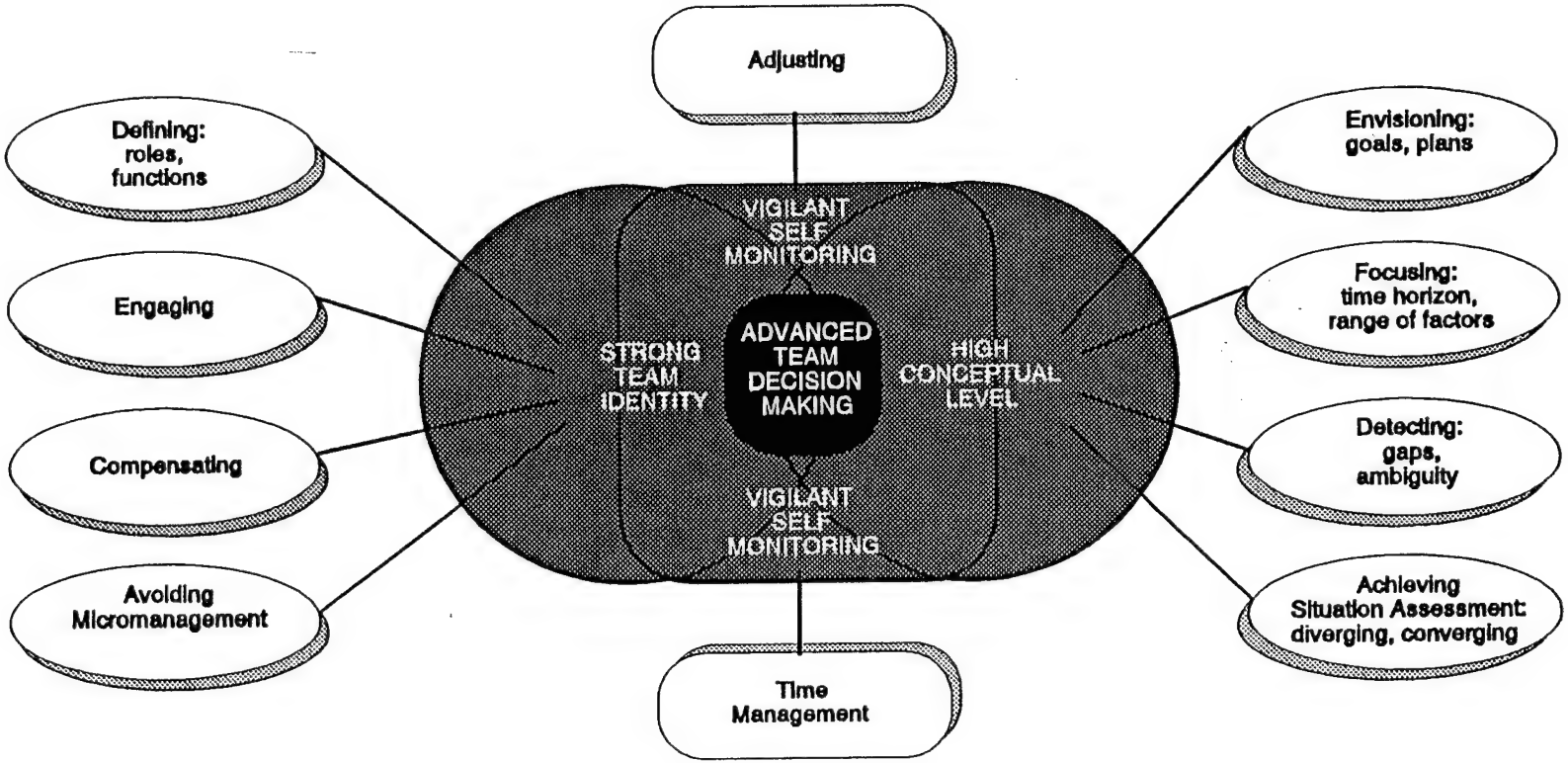

Figure 1. ATDM Model.

The component of Team Conceptual Level also contains four behavioral markers. Envisioning goals and plans requires specific, concrete language that is put into a context relevant to the team members, both through examples that relate to their experience and through outcomes that contrast success and failure. The second behavioral marker, focusing on time horizon and range of factors, refers to the team's ability to consider an appropriate span of time (time horizon) and a relevant breadth of concepts and information (range of factors). Detecting gaps and ambiguity, the third behavioral marker, concerns the ability of a team to discover and fill holes in the team's information base and to recognize and handle inconsistencies or contradictions that might be present. Finally, achieving situation assessment by diverging and converging involves actively seeking a variety of views from team members about plausible situation assessments or plans, and then ensuring that all members share a common understanding of the assessment that the team eventually accepts.

Within the component of Team Self Monitoring there are two dimensions: adjusting and time management. Adjusting is the ability to modify the way the team is performing when problems are discovered through the monitoring function. Time Management refers to the ability of a team to meet goals before deadlines overtake them, to sequence sub-tasks effectively so that output from one task connects where and when it should as input to the next task, and to maintain a strategic allocation of time to sub-tasks in terms of their priority for reaching the overall goal.

The ATDM model was evaluated in an experiment conducted at the Air Force Institute of Technology (AFIT) in Dayton, Ohio, where students were engaged in a strategic planning and management exercise (Zsambok & Kyne, 1991). The simulation played over three days and observers were present in all sessions. The two treatment teams received feedback based on the ATDM model and the two control teams received no feedback. Outcome measures concerning each team's decision-making behaviors and the quality of each team's product were collected. Results showed that over the three-day period, the treatment teams improved by 73% in their decision-making behaviors, while the control teams improved by 28%. The objective measure of team product quality revealed that, over the three-day period, the treatment teams products steadily improved and then surpassed the control teams products in their quality.

As ATDM was developed as a result of our Phase I research, we drew greatly from it but also used other team performance models to create an expanded model. The process of using the literature to develop the Advanced Team Performance (ATP) model is described in the next section.

Literature Review

We performed an extensive literature review in order to further our understanding of the relationship between the ATDM model and other accounts of team performance. The literature review followed three tracks: general literature about team processes, literature from the command-and-control domain, and team literature from the industrial/

organizational psychology domain. We focused on general literature about team processes in order to gain an understanding of the research that has been conducted in this area, with hopes of synthesizing this broad and sometimes scattered literature. We studied current command-and-control literature not only because it is the domain in which this project takes place, but also for another purpose: while much of the general literature concerning the nature and processes of teams is abstract—with minimal discussion of concrete, observable behaviors and concepts—much of this military literature contains information which can be analyzed from a concrete, observable level.

The review began with an identification of leading summary and theoretical accounts of team performance. Two hundred and eleven articles were studied. Of these, 200 dealt with either industrial and organizational teams or military teams. The remainder were supplementary readings that did not have a team focus, but were necessary for understanding the primary literature or the C^2 domain. (See Appendix A for a selected listing of these articles.)

Three criteria were then used to categorize the articles. Primarily, we were interested in whether the article focused on interpersonal relationships among team members and individual member's skills, or on the team as a whole. Many articles, models, and theories consider the most important aspect of teams to be relationships among team members, along with the personality, qualities, and abilities of the team's members (e.g., Bass, 1975, 1982; Dieterly et al., 1983; Hackman, 1965, 1968, 1983, 1990; McGrath, 1984; Payne, 1990; and many others). These literatures commonly focus on the optimal composition of a group in terms of skills, personality types, etc.; group dynamics; the optimal number of members that should be in a team; the cohesiveness of the members; and the like. While these aspects are undeniably important in the functioning of a group, the teams commonly dealt with in naturalistic settings are composed of members who cannot be moved around or dismissed because of their Myers-Briggs (Myers, 1991) classifications. The members of teams in naturalistic settings are usually present because of their skills, occupation, or personal interest in that particular group. Therefore, we chose to focus on literatures which considered the team as a whole, looking at the processes, performance, and training of a team as an entity. Of the 200 articles concerned with teams which we examined, 40% seemed to focus on the team as a whole, while 60% focused on interpersonal relationships or individual members.

A second division of the articles was on whether or not the model contained measurable markers or components. Many articles concerning teams, especially in the academic literatures, focus on abstract constructs developed into theories which, while they may have testable hypotheses, do not contain concrete behaviors. In order to perform the type of objective analysis planned for this review, it was necessary that highly concrete markers or components were available for classification. Generally, more concrete markers were found in literatures containing an assessment tool of some kind. Where possible, we extracted markers and/or components for analysis from those articles. We also considered historical and theoretical articles on the lines of research that these markers and components

The literature was also divided according to the level of model development: articles which contained full models; those which contained partial models (or no model per se, e.g. articles examining a single component of team process, such as cohesion); articles which focused on training and evaluation in such a highly contextualized way that explicit models were not presented; and literature reviews. Eventually, we found it necessary to focus our analysis primarily on lines of research that were defined as models by their developers.

Through the process described above, six lines of research were chosen for analysis. These will be described briefly below. For a full description and the reasons for their inclusion in the analysis, see Militello, Kyne, Klein, and Thordsen (in preparation).

The first line of research considered was the TEAM model developed by a group of team researchers for NTSC, in which the team is viewed as an information-processing entity. This model is adapted from Morgan, Glickman, Woodard, Blaiwes, and Salas (1986) and is a combination of the work of Tuckman (1965) and Gersick (1988, 1989). The second line of research was conducted primarily by McIntyre and Dickinson (1992), in which the same TEAM model was utilized but a significantly different assessment tool was developed, was also considered. A third, more descriptive literature included in analysis was a group of articles that began with the Nieva, Fleishman, and Rieck (1978) taxonomy of team performance, and continued through many iterations (e.g., Cooper, Schiflett, Korotkin, & Fleishman, 1984; Shiflett, Eisner, Price, & Schemmer, 1982).

The fourth literature chosen for analysis is the Mission Performance model developed by Smith, Helmreich, Demuth, and Lofaro (1991). We focused specifically on the portion taken directly from Helmreich's work with Crew Resource Management (CRM) (1986). We felt the inclusion of Helmreich's work was necessary for a complete, inclusive analysis of team literature. Not only does it examine teams from a highly proceduralized domain (airline cockpit crews), adding an important contextual dimension to the analysis, but Helmreich's work is also highly respected in the team literature paradigm, in both military and academic domains. The fifth literature, well established in the military domain, is the organizational model of command-and-control teams developed by Olmstead (1990). Finally, the ATDM model (Zsambok, Klein, Kyne, & Klinger, 1992, 1993) was included in analysis.

Analysis of Markers and Components

We, thus, began a more formal analysis of the literature. The aim of this analysis was to map the components and markers extracted from the literature onto a common framework, to synthesize these literatures in order to gain the broadest possible understanding of what has been discovered about team processes to date. Because we were interested in identifying commonalities and idiosyncracies among the six lines of research, we began with a comparison of the models. This comparison was conducted by listing all the behavioral markers articulated in each model and charting them, noting both areas of overlap and outliers.

After this initial comparison, we felt it would be expedient to map all the models directly onto one framework. Although any of the models would have been appropriate to serve as a base for this framework, we chose to use the ATDM model for several reasons. ATDM captures a broad range of team components, encompassing many of the behaviors noted in the other models. The structure of the ATDM model allows for discrete steps from the higher conceptual level to specific instances of observable behaviors. ATDM's base in cognitive psychology provides a theoretical foundation for further study. Finally, because ADTM was developed at Klein Associates, the research team is most familiar with this model.

As a result of this analysis, we found many similar concepts and behaviors (summarized in Table 1) among the six models which had a direct impact on the formulation of our current model, the Advanced Team Performance (ATP) model. These findings, along with their corresponding impact, are presented below.

The concepts of team performance that are most noted in the literature are the processes of defining roles and functions, engaging, envisioning goals and plans, and team self monitoring (e.g., Carnevale, Gainer, & Meltzer, 1990; Dubnicki, 1991; Fleishman & Zaccaro, 1993; Glickman, Zimmer, Montero, Guerrette, Campbell, Morgan, & Salas, 1987; Kazemek & Albert, 1988; McIntyre & Dickinson, 1992; Sisco, 1993; Smith, Helmreich, Demuth, & Lofaro, 1991; Tolle, 1988). These processes also appear to approximate commonly accepted definitions of teams. For instance, Dyer (1984) states that a team consists of at least two people, who are working towards a common goal/objective/mission, where each person has been assigned specific roles or functions to perform, and where completion of the mission requires some form of dependency among the group members. Dependencies are further described as verbal communication or physical interaction among members, or learning how to react to and anticipate the actions of other members. These four components are present in the most current ATP model.

Another common theme in the literature is the team's use of resources. Resources are commonly referred to in the context of automation and equipment operation and how they will be used by team members to accomplish the goal. Because resources are used by members to fulfill their functions, the notion of resources is included in ATP under defining roles, functions, and resources.

Communication is an obvious and necessary component of teamwork and is a major component of team processes in four of the six models. It is either included as a separate component (Glickman et al., 1987; McIntyre & Dickinson, 1992) or paired with an informative object such as "communication information" (Olmstead, 1990) or "communication/decisions" (Smith et al., 1991). In the ATDM model, the dimension of engaging addresses the concept of communication most directly and refers to the team's level of involvement in reaching the goal. Communication is inherent in the other components of ATDM. Furthermore the kind of information that ought to be communicated is determined by the behaviors that represent each dimension. For instance, the behaviors that represent the dimension of "envisioning goals" might be that the goal is articulated by the commander

in a clear manner with time and geographical boundaries. ATP model views communication similar to the way in which ATDM does.

Leadership was not addressed directly in the ATDM model, but is implicit in the concept of self monitoring as the entire team is responsible for monitoring its team decision-making behavior and adjusting where necessary. Other literatures address leadership directly (Kazemek & Albert, 1988; McIntyre & Dickinson, 1992; Sisco, 1993; Smith et al., 1991). We found that many of the leadership behaviors presented in the literature consist of a management function. Therefore, we include in the ATP model a Self-Management component in order to address these leadership and team self-monitoring behaviors.

Compensating is a dimension in the ATDM model referring to a situation in which one team member steps in to fill a gap left by another member. ATP carries this a step further by including behaviors identified in the literature where a team member may not only step in to fill a gap, but also coach the less-capable member so that the need to compensate will not be necessary in the future. The ATP model has thus expanded to include both a compensating and coaching function.

Decision making is a recognized function of teams. Both Olmstead (1990) and Helmreich (1984) refer to them explicitly in their models of teamwork. Olmstead refers to the decision making process as the "deliberative activities of one or more persons leading to the conclusion that some action will, or should, be taken by the organization." It is evidenced by communication of the decision and instruction issued by the decision maker. Smith et al. make use of Helmreich's Crew Resource Management to form a component of mission performance labeled, "communication process and decision behavior." The dimensions within this component address briefings, assertiveness of crew members, self critique, conflict resolution, and communications. ATP model also dedicates an entire component to decision making utilizing elements of the Recognition-Primed Decision (RPD) model (Klein, 1989) which describes individual decision making in naturalistic settings.

Current Form of the Advanced Team Performance (ATP) Model

For the purposes of this project, we have developed an expanded model of team performance that is applicable to the C^2 environment. In doing so, we have borrowed heavily from the ATDM model and also incorporated the concepts and behaviors of other team performance models identified in the literature review. The ATDM model was designed for strategic planning teams in relatively unstructured settings such as the exercises at the Industrial College of the Armed Forces, where simulations are conducted of National Security Council tasks. In contrast, the present contract is to evaluate battle staffs at the Brigade/Battalion level during planning, preparation, and execution phases. Therefore, we needed to develop an expanded model to handle a more hierarchical authority structure, along with real-time adaptation to dynamic events. Interviews with our consultants suggested that the evaluation of teams needed to include the individual competencies of the members, as well as the careful evaluation of a plan to make sure all components were synchronized.

Table 1

Concepts and Behaviors Identified in the Literature

CONCEPTS AND DIMENSIONS	MODELS OF TEAM PERFORMANCE (referenced as appears in text)					
	CRITICAL TEAM BEHAVIOR FORM Morgan et al., 1986	TEAMWORK BEHAVIORAL SUMMARY SCALE McIntyre & Dickinson, 1992	TAXONOMY OF TEAM PERFORMANCE FUNCTIONS Nieva et al., 1978	MISSION PERFORMANCE MODEL Smith et al., 1991	BATTLE STAFF INTEGRATION Olmstead, 1991	ATDM Zsambok et al., 1992, 1993
TEAM CHARACTERISTICS						
Member/Leadership Competence	✓	✓	✓			
Shared Practices (SOP Proficiency)	✓	✓	✓			
Command Climate					✓	
TEAM IDENTITY	✓	✓	✓	✓	✓	✓
Defining Roles & Functions, Resources	✓	✓	✓	✓		✓
Engaging All Members	✓	✓		✓		✓
Compensating & Coaching	✓	✓	✓	✓		✓
TEAM PLANNING & DECISION MAKING				✓	✓	✓
Envisioning Goals	✓	✓	✓	✓		✓
Maintaining Dynamic Focus	✓			✓		✓
Situation Assessment		✓	✓	✓	✓	✓
Envisioning & Evaluating Courses of Action (Synchronization)			✓	✓		
Articulating Expectations			✓			
TEAM SELF MANAGEMENT	✓	✓	✓	✓		✓
Monitoring	✓	✓	✓	✓	✓	✓
Adjusting	✓	✓	✓	✓	✓	✓
Detecting Gaps & Inconsistencies	✓	✓		✓	✓	✓
Time Management	✓	✓	✓	✓		✓

(The strategic-level planning exercises did not require this level of scrutiny.) Besides our finding from the literature of the importance of the use of resources, our consultants also recommended that we expand the dimension of "Defining roles and functions" by adding "resources" as another component to be defined.

It is important to see these types of elaborations as natural extensions of the basic ATDM model as it is applied to different domains. The extensions are not criticisms of the ATDM model, and do not identify weaknesses in that model. To the contrary, the basic structure of the ATDM model remains intact as the framework of the ATP model we will be using in this project. All the higher-level components of the ATDM model have been retained. One new concept has been added, to reflect additional characteristics such as the proficiency of the team.

The ATP model is presented in Figure 2. There are four components or higher-level concepts to the ATP model: team characteristics, team identity, team planning and decision making, and team self management. These fit together in the following way: A team needs to develop a minimal level of proficiency before it can do a job. It makes no sense to speak of the team's identity until it reaches the level where it can reliably handle tasks. Once this proficiency is in place, the team will find that the members are decentering. They are now able to consider the needs of the team, and not just the requirements of their individual tasks. Once the members have decentered, and have learned to identify themselves as part of a team, they can engage in complex decision making, because they are able to appreciate how goals must be clarified for all members, how situation assessment must be shared, and so forth. Finally, when the team is working together to make decisions and solve problems, it is able to assess itself, enabling the process of self management.

Let us examine the four components of the ATP model in greater detail. Each component addresses elements of team processing at a conceptual level, but also includes several dimensions which address the same elements but at an applied level. These components and dimensions are intended to be general across different domains. In contrast, the particular behavioral anchors used to evaluate the dimensions and components need to be specified for any given domain.

Team Characteristics

This component refers to the ability of a team to get a job done. Within Team Characteristics there are three dimensions.

Member/Leadership competence. One of the first things an evaluator looks at is the ability of the individuals to handle their own tasks. If the general ability level is low, then the team will not be capable of sophisticated plans. If the ability level is high, with only one or two exceptions, the team might prepare to shift around roles, or bring in more help. The team leader is assessing the competence of the subordinates, and the subordinates are also assessing the leader's competence.

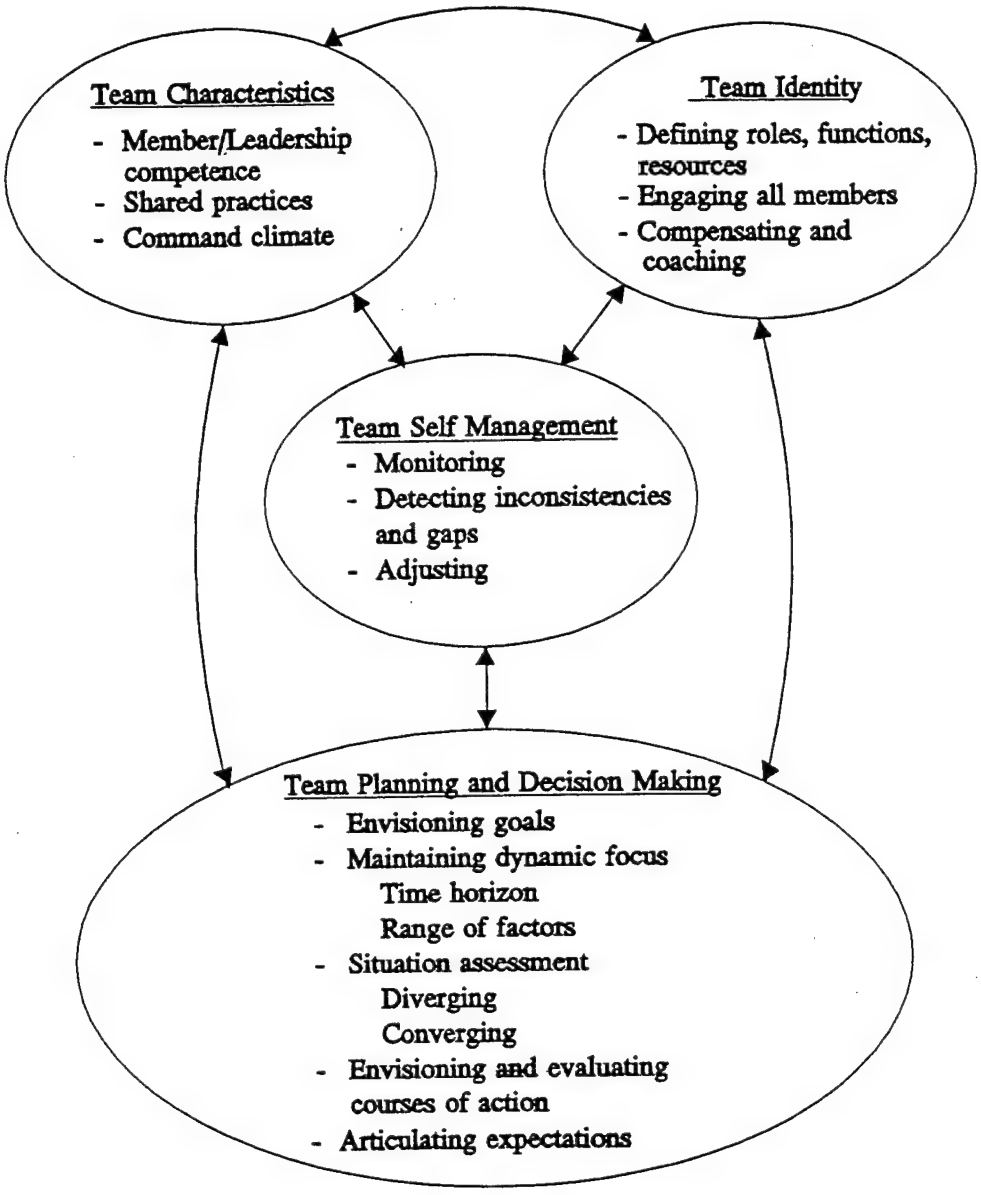

Figure 2. ATP Model.

Shared practices. With experience, teams build up shared practices or procedures for performing routine operations, so that these are "chunked" or "automatized" and do not require attention, leaving the team able to devote its energies to the difficult problems that must be solved.

Command climate. There are many aspects of command climate, but for advanced team performance one of the most important is the initiative of the team members and the willingness to take risks. When nonroutine events occur, this initiative is essential to flexible reactions.

Team Identity

This component refers to the team's movement towards decentering, when people think of themselves more as members of a team and less as individuals performing jobs. In our review we found that much of the literature on teamwork has concentrated on this component, referring to it as morale, team building, team maintenance, and so forth. The Team Identity component contains three dimensions described below.

Defining roles, functions, and resources. Teams have to work out which roles the members will have, which functions they will perform, and which resources they will have available. Some teams know all of this going in, some take extra time to make sure everyone is clear about how the team is going to work. Other teams have to figure it out from scratch. And some teams skip this step and run into confusions and conflicts later on. Defining roles and functions is part of the ATDM model, and covers the explication of who is going to do what. In a tactical domain the team will also have to consider resources available to do the job. (For this application of the Advanced Team Performance model to brigade/battalion TOCs, we expect that one of the behaviors signifying that everyone knows his/her roles is whether the team already has established procedures with which everyone is familiar, or whether the team has to figure out new procedures—on the spot, or even after the work begins.)

Engaging all members. Teams do best when all members are engaged in the task; the strongest teams work to bring members who start to disengage back in.

Compensating and coaching. In order to get a task done, team members sometimes may compensate for others who are experiencing difficulty (high workload, lack of skills). This compensation is excessive if it compromises other functions. Teams can avoid the need for continual compensation by coaching members and giving them on-the-job training to get them up to speed.

Team Planning and Decision Making

It is with this concept that the ATP and ATDM models step free of the approaches used in the past. The previous examinations of teams concentrated entirely on the cohesiveness of teams, whereas our work has also looked at the factors that allow teams to make effective decisions, and solve problems. In recent years a few researchers have begun to clarify the important decision-making processes of teams. Orasanu, Fischer, and Tarrell (1993) have shown how communications patterns tie in to effective decision making among cockpit crews. Cannon-Bowers, Salas, and Converse (1992) have described the importance of shared mental models. These projects influenced our work in developing the ATDM model, tying together the process of team decision making.

The ATP model has further refined this concept, defining a specific cluster of dimensions as Team Planning and Decision Making. The dimensions within this component were selected from our observations and studies of many different types of teams. We

identified the primary functions that differentiate some teams as effective decision makers, from others who have difficulty. We found that the primary dimensions making up this cluster mapped onto the Recognition-Primed Decision model (Klein, 1989) of how individuals make decisions in naturalistic settings (see Figure 3). Therefore, we have arrived at a recognition of common patterns in team and individual decision-making strategies.

Envisioning goals. Teams need to have a shared understanding of the outcome towards which they are striving. For our work with the Army, we will be referring to this dimension as "Commander's Intent," even though the process will include responsibilities of subordinates to clarify the nature of the intent where necessary, and even to help formulate the intent. This dimension also appeared in the ATDM model. It maps onto the RPD model with regard to the aspect of situation assessment covering goal recognition.

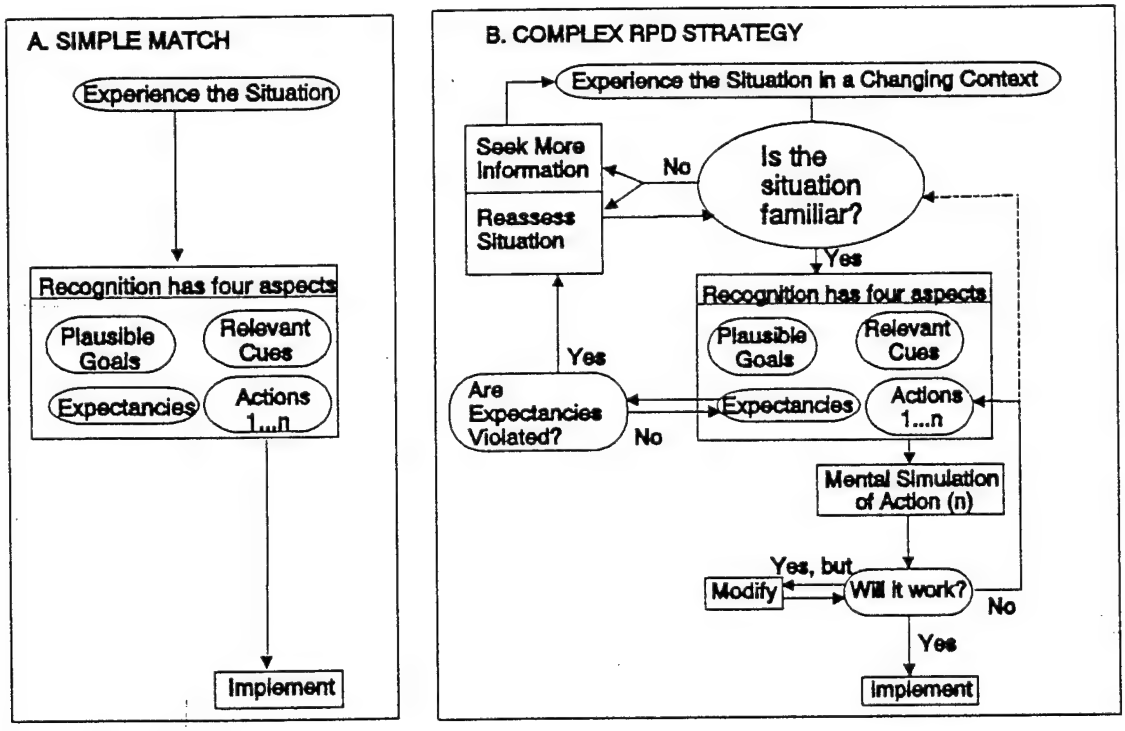

Figure 3. Recognition-Primed Decision Model.

Maintaining dynamic focus. Teams have a limited attentional capacity, so it is important to keep attention directed at the most relevant cues, in terms of the time frame the team is dealing with, and the range of factors the team is considering. This dimension is also found in the ATDM model. It maps onto the RPD model of individual decision making with regard to the aspect of situation assessment covering critical cues.

Situation assessment. We found that teams needed to share a common assessment of a situation (this overlaps with the shared mental model concept articulated by Cannon-Bowers et al., 1992; Orasanu & Salas, 1993). Teams needed a shared understanding of the goals. The ATP and ATDM models both treat this dimension in the same way. It refers to two things, the actions a team takes to form a shared mental model, and the team's ability to construct and hold onto alternative hypotheses about what is happening. We can think of these as converging and diverging operations. The converging part would be assessed by looking for behaviors involving the use of maps, diagrams, messages, meetings, to make sure the relevant people know how they are all viewing the situation. The divergent part shows how the team can handle ambiguity, and seems very important to counter a team's fixation on only one hypothesis about the nature of the situation, which would enable a team to fool itself. Too much convergence can result in groupthink. Too much divergence results in confusion.

Envisioning and evaluating courses of action. Teams need to identify and evaluate options, just as individuals do. In the RPD model, the option evaluation function was described as taking place through a mental simulation of the option, to see if it will run into any problems or disconnects, and to game out how a plan would be coordinated and conducted. In the military environment, one way this occurs is through synchronization charts. The idea behind this dimension is to assess how well a team uses its collective experience to troubleshoot a course of action in advance of implementing it.

Articulating expectations. Teams need to have a clear situation assessment to form expectancies and to notice when these are violated. This is especially important in dynamic settings, to notice places where a plan is breaking down in time to do something about it. In the RPD model, when an experienced decision maker forms a situation assessment, that process generates expectations that can be used to check on the accuracy of the situation assessment. If the person has misidentified the situation, mismatches should appear to flag the problem. We have added this dimension to the ATP model because teams have to do the same thing: generate and monitor expectancies. The team has a more difficult job because the individuals receiving the messages have to be alert to what constitutes a violated expectancy. Too often a red flag appears only to be ignored because the individual in charge didn't realize its significance. For a dynamic, operational mode this dimension relates to the alerting function, the team's ability to grasp the significance of a message and react quickly. The dimension of "Articulating expectations" did not appear in the ATDM model because that was applied to slower-moving incidents and strategic issues. We felt that it was important to sharpen the ATP model for capturing the requirements of dynamic settings.

Team Self Management

This concept refers to a team's ability to observe itself and make changes as necessary. It covers a team's ability to adapt. The overall concept remains the same as was posited by the ATDM model.

Monitoring. The team needs to observe itself for signs of breakdown on any of the components or dimensions. Additionally, the team needs to monitor the way it is using time and other resources to complete its task.

Detecting inconsistencies and gaps. In reviewing the other three components of the ATP model, team characteristics, team identity, and team planning/decision making, advanced teams search for inconsistencies and for missing items of information. There may be inconsistencies or lack of resolution about roles, or about procedures, or about situation assessment. Sometimes a team can work to clear up the inconsistency. Other times a team must live with it. The advanced teams we have observed are less threatened by ambiguities, and will make it clear that there are different understandings, rather than fixating on a single interpretation and blinding themselves to the other possibilities.

Adjusting. When the team notices a problem it needs to respond to it. If the team fails to respond, then the problem may get worse. Conversely, the team may over-respond, particularly in cases where the leader impatiently takes over someone else's function. This leads to micromanagement. So both ends of the spectrum are dysfunctional, under-responding and over-responding.

The ATP model is continuing to develop, and will undoubtedly be modified as we advance into the field testing scheduled to begin in the summer of 1993. This section documents the current form of the model. The ATP model represents one way of capturing important team functions, and must be judged on its utility rather than on the way it has chosen to represent different processes. The ATP model does not have a specific dimension to address leadership. In the ATP model, the role of the leader is addressed as part of the dimension of defining roles, functions, and resources. The performance of the leader is addressed as part of the dimension of evaluating the competence of the team members (*Member/Leadership competence*). And, the functions of the leader are captured in the concept of Team Self Management. These are primarily the leader's functions, but where necessary they can and will be performed by other team members.

Two other areas of current discussion include time management issues and team personality issues. We have not, at this writing, arrived at final decisions concerning these dimensions. While the relevance of these issues to team processing is clear, we are in the process of determining boundaries for the concepts in order to form meaningful definitions and determine appropriate placement within the model. These concepts will be incorporated into later versions of the model.

Current Accomplishments

The project has been continuing for ten months, and thus far we have achieved a number of outcomes. The first of these is the completion of our review of the literature review. Our findings have confirmed the ATDM model as a valid model upon which to build. The literature review has also aided us in adapting the ATDM model to be more generalizable and better fit the domain of interest. We are in the process of preparing an

article which will explicitly detail the process used in analyzing the literature and our findings (Getchell-Reiter et al., in preparation).

Additionally, we have expanded previous models of team performance to develop the ATP model. As described above, we are in the process of refining the ATP model. This expansion will lead to a model that is both more general and more testable. An article in preparation will both describe the ATP model and highlight the advantages of ATP over other existing models.

We are in the process of developing an observation guide for Observer/Controllers. The goal of the guide is to provide OCs with a means for distinguishing effective from ineffective teams and the processes that contribute to these differences. We also intend to develop a corresponding instructional tool to help them teach teams to achieve increased performance more quickly.

We have determined that the observational guide will most likely use a five- to seven-point scale to identify the level of team functioning on each dimension. Each anchor on the scale will consist of a number of various behaviors reflecting the team's level of performance. The process for developing the scale includes using subject-matter experts (SMEs) to identify behaviors. Other SMEs will then be asked to validate the behaviors using a sorting task. Eventually, this guide will be tested using the SIMNET facility at Ft. Knox, and will be revised based on those results.

The final form of the instruction tool is yet to be determined. However, our objective for this tool is to give OCs a new perspective for viewing teams.

Preparation for Field Application

The next steps in the contract are to field test the ATP model and observation guide, evaluate them, and revise and strengthen them. Throughout this process we will continue to consult with individuals experienced in Army tactical operations centers in order to solicit their suggestions and recommendations regarding our model, methodology, and measurement scales. We will be specifically interested in understanding the SMEs' assessment criteria, eliciting comments from the SMEs concerning the adequacy of the behavioral markers, and receiving additional input regarding how to make the package more compatible with military terminology and philosophy.

Develop Instructional Package

One of the ultimate objectives of this project is to develop a methodology by which training personnel (e.g., observer/controllers) can assess the effectiveness of battalion and brigade battle staffs. To enable them to do this, we will develop an instructional package which will describe the logic underlying the model and measurement scales and the use of both. Material in the instructional package will be based on all the information gathered up to this point.

Field Applications

We plan to conduct two sessions of domain testing in which exercises will be carried out using SIMNET. OCs will be asked to assess the team using our evaluation guide. After each session, the guide will be revised to accommodate the input received from OCs and our own field observers.

Finally, the evaluation guide will be tested in a series of field studies with two units both at their home station and their respective combat training center (CTC). At this point, our goal will have shifted from the revision and development of the tool to the actual evaluation of a final product. At the CTC we will observe the units under the most realistic conditions possible in non-war circumstances. Thus we will be able to see how well the methodology captures the teams' performance under the existing conditions and where discrepancies exist.

Conclusion

To conclude, the first phase of this project was spent developing a general model of team performance. We have completed a comprehensive review of the team performance literature in several domains. This information was combined with our previous work in the area of team performance and decision making to develop the ATP model, which describes team performance at both a conceptual level and an applied behavioral level.

We are now making the transition from theory to application. In the next phase we will validate the ATP model with brigade and battalion level command-and-control teams. We will create a evaluation guide to be used by OCs in evaluating team performance and identifying appropriate training interventions.

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Appendix A
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